

Viscoelastic Uplift and Patagonian Glacial Demise: A Numerical Model and Potential Geodetic Observations

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Glacial moraines of the icefields of the southernmost Andean Cordillera record several periods of advancement and retreat during the mid and late Holocene. These glacial changes may be related to variations in precipitation and/or atmospheric temperature. Four C-14 dated Neoglacial advances and retreats of the Patagonian icefields during the last 5 millennia (Warren and Sugden, 1993, *Arc. Alp. Res.*, 25) are modeled as ice surface loads that force viscoelastic gravitational deformation of the solid Earth. A parameter study indicates that crustal uplift rates could be similar to, or perhaps exceed, those known to be presently occurring in Fennoscandia and Hudson Bay (10 mm/yr). The study includes considerable complexity in the temporal load history, including the effects of the annual hydrological cycle and 3 Neoglaciations that predate 10,000 BC. Recent analysis of glacial recession over the period 1944-1985 (Aniya et al., 1997, *Arc. Alp. Res.*, 29) indicate that the Northern and Southern Patagonian icefields ablate at a rate of 1.2 and 2.4-7.3 cubic km/yr, respectively, during the 20th century. A viscoelastically enhanced isostatic uplift is a consequence of Little Ice Age (1400-1750 AD) glacier advancement and 20th century retreat. Solid Earth viscoelastic structure is critical to the predicted uplift amplitude. A weaker mantle/crustal rheology and thinner elastic lithosphere, relative to Fennoscandia, promotes a fairly strong interaction between the solid Earth and sub-millennial time scale glacier fluctuations. If the effective upper mantle viscosity is roughly $\eta = 10^{20}$ Pa s then large, and geodetically detectable, surface uplift occurs at present-day. Although a viscosity value near 10^{20} Pa s is lower than thought typical of continental shield mantle (e.g. Fennoscandia), the value is consistent with island arc environments and the regional tectonic setting of Patagonia. Observational strategies using GPS and SAR have potential for defining the pattern and amplitude of uplift in Patagonia.